Honeywell Analog Computers

What! Me buy a Computer?

Certainly

if it's a special kind of computer applied to do a special kind of job. There's a good chance that this kind of computer could pay for itself in less than a year and make a profit for you from then on.

We're not talking about an initial investment somewhere in the six-figure area (the four to five-figure area is closer). And we're not talking about complex feasibility studies that can cost you hundreds of engineering man-hours—or about additional investments in programming and maintaining a digital computer-directed control system.

Don't get the idea that we are underrating digital computer-directed control (our H610 digital process control computer is more powerful, and more reliable than any computer in its price class). These heavyweights of the computer industry are doing an outstanding job on many process and scientific applications.

PULP PRODUCTION

Pulp production in a continuous digester is a good example. The Pulp Mill Superintendent is mostly interested in the pulp yield (proper amount of lignin removal) to produce a pulp of a particular quality required by the papermaker. But, the only way he can directly measure pulp quality is to take periodic samples and analyze them in the lab. And, between sampling periods, a lot of off-quality pulp can be produced.

Pulp quality is affected by variables such as the alkali-to-wood ratio and the temperature required' for a given wood specie at a particular throughput rate.

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But, there are and always will be cases where conventional control loops just do not do a satisfactory job, but where an on-line digital computer system can't possibly pay its own way.

For many of these cases, the answer is a special (or single) purpose analog computer. Before going into just what these computers are and how they operate, let's take a quick look at a few places where they are justifying their existence.

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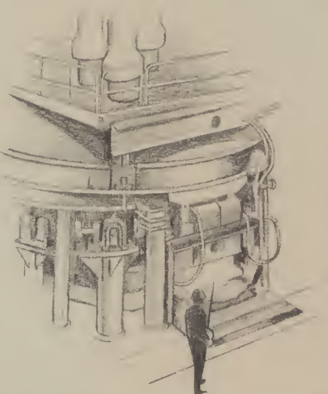
out the relationships of these variables in terms of pulp quality. Honeywell systems engineers designed a special purpose analog computer that would continuously solve this equation. This computer system automatically controls the digester to produce constant grade pulp despite changes in any of the variables concerned.

Without the computer system, here's what the operator had to do when a change in production requirements called for a change in wood species or throughput rate: during the period of changeover (which might be 7 or 8 hours), he had to continuously alter the set points of as many as 20 control instruments; and he had to be able to repeat this operation a few days or weeks later when production requirements again changed.

The computer system automatically changes certain key controller settings to the proper values at the proper times. It also tells the operator when to change other controller settings so that, at the end of the changeover period, both pulp quality and production rate will be exactly as specified.

POWER DEMAND



Power demand is another area where the special purpose analog computer fills a real need. One steel company, for example, batch melts scrap in four electric furnaces. The power used by this plant in a 24-hour period could supply the electrical needs of 94,000 average-sized homes.

This company pays its monthly electric bill in two parts: (1) a basic charge for all kilowatt-hours used; and (2) a billing demand charge that contracts for a pre-

Where large quantities of electric power are used, this special purpose analog computer can quickly pay for itself. It automatically monitors, computes, and totalizes the instantaneous load throughout the demand period, drops loads as needed to avoid penalties, and signals operators when they should increase the load to use all available power.

agreed maximum kilowatt usage during a 30-minute demand period. The second charge must be paid even though not all of the agreed-upon power is used. But, and here's the catch, if, during any one demand period, the power usage *exceeds* the agreed-upon value, there's a charge for the excess kilowatts. And this charge must be paid for the next 24 months. To handle this ticklish control situation, the steel company kept four load dispatchers busy full time. And, to guard against excess charges, the dispatchers used a production-limiting safety factor.

What was needed was some means of continuously solving the following equation:

$$\int_0^t P\,dt + P(T-t) = DT$$

where:

P = instantaneous power being consumed at any time in the demand period.

T = total time of demand period (30 min. in this case).

(T–t) = time remaining in demand period.

DT = amount of power available in demand period.

Our systems engineers supplied a special purpose analog computer that fills this need. It automatically monitors, computes, and totalizes the instantaneous load throughout the demand period. Furnaces are automatically dropped from the load as necessary. Operators are signaled when they should increase the load to use all available power.

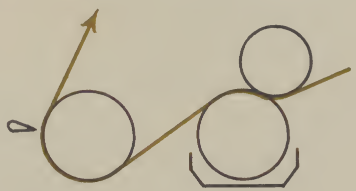
The results?

A net tonnage income increase.

Cost of the computer system?

Around $20,000.

COATING WEIGHT



Coating weight is important to the manufacturer of coated papers. When he applies too little coating, he gets off-grade paper; when he applies too much, he wastes coating material and loses money. While it is technically possible to measure coating weight directly, the measuring system needed is usually too expensive.

Here again we were able to supply a special purpose analog computer system to fill the need. In this case the computer continuously solves the formula:

$$W = \frac{K_1 \times S \times F}{K_2 \times V}$$

where:

W = dry coating weight (lbs/ream)

K_1 = mill ream standard (sq ft/ream)

S = density factor of coating solution

F = flow rate of coating solution into level tank (gal/min)

V = sheet surface speed (ft/min)

K_2 = sheet width (in)

For a given run, the operator sets factors K_1, K_2 and S into the computer manually. To do this, he uses the calibrated input knobs (shown in the illustration) which position 10-turn potentiometers. He also sets the desired coating weight (W) on a weight-of-coat recording controller that's part of the computer

system. Factors F and V are continuously measured by other instruments in the system and enter the computer as electrical inputs.

By automatically maintaining the desired coating weight, one of these computer systems can save enough in coating material to pay out within a year.

Close-up of weight-of-coat computer shown on panel below. For a given run, operator sets sq. ft./ream, sheet width, and density factor into the computer, and desired coating weight on the recording weight-of-coat controller (instrument at far right of panel below). Flow rate of coating solution, and sheet surface speed are continuously measured by other instruments in the system and enter the computer as electrical inputs. Computer-directed system then automatically maintains correct weight.

By automatically controlling the amount of coating material applied to coated paper, this computer-directed weight-of-coat control system can pay out within a year. Special purpose analog computer (top center) solves coating formula based on several process variables.

BASIC OXYGEN STEELMAKING

Basic oxygen steelmaking is one of the latest developments in the steel industry. But the very speed that gives it an edge over traditional steelmaking, makes the proper proportioning of each furnace charge more critical. Any error in the proportions of hot metal, scrap, and lime can seriously affect the quality of the heat. And, the time the operator takes to correctly calculate these proportions fixes the length of time the furnace has to be down between consecutive heats.

The equations used to work out the necessary proportions are lengthy and involved. Solving them manually would eat up a lot of time and there would always be the chance of human error.

In less than a minute, the melter on a basic oxygen furnace sets up a charge formula problem on this Honeywell special purpose analog computer. In seconds, he reads out the exact amounts of hot metal, scrap, and lime needed for the heat. This compact computer is dust-proofed for use in the hot steel mill environment, and mounted on wheels for ready plug-in interchangeability between furnaces.

With a Honeywell special purpose analog computer system, the melter can set up a charge problem in less than a minute. To do this, he sets into the computer data such as hot metal temperature, silicon and manganese content, total charge weight, tap temperature, and basicity ratio. In the next few seconds, he has a six-digit solution displayed in engineering units directly corresponding to the process variables.

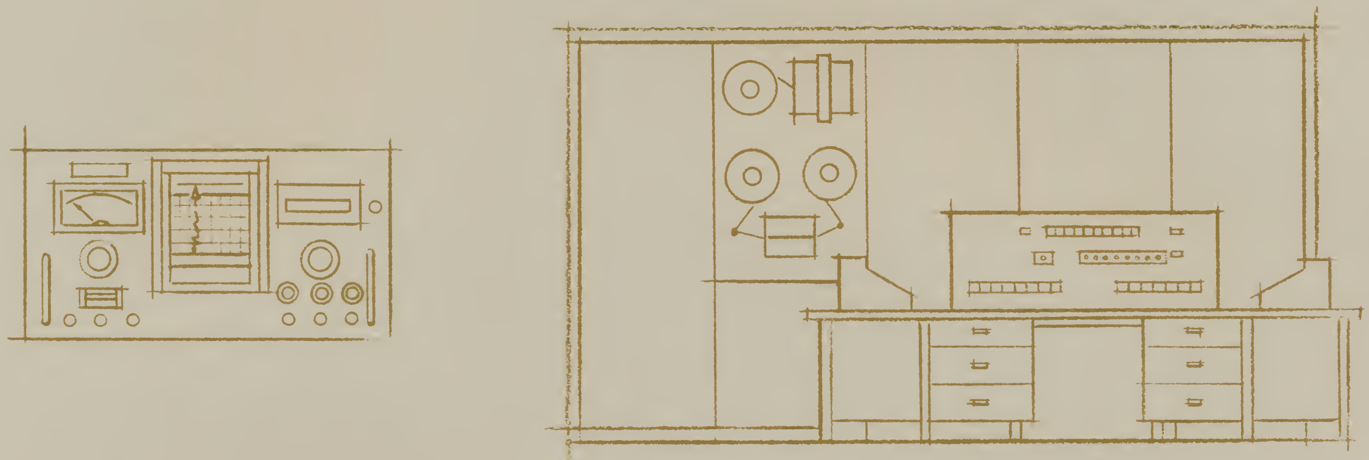
SCIENTIFIC PRODUCTS

Scientific products often offer opportunities for the application of this very special kind of computer. A case in point is the matter of Xenon gas poisoning that occurs during the operation of a nuclear reactor. Xenon gas is an inert by-product produced by nuclear transformation of other elements. As its concentration increases, it poisons (slows down) the nuclear reaction, stopping it completely after a certain level has been reached.

In this case, the scientists wanted to know the poisoning effects of various concentrations of Xenon gas. The relationships of the variables involved could be expressed in ordinary differential equations. From these, our systems engineers were able to provide a special purpose analog computer that would monitor actual Xenon gas buildup during reactor operation and predict the effect on the reaction.

With the computer system, the reactor can be operated at higher efficiency. Reactor down periods are of shorter duration and frequency, and operating conditions are safer.

Mass flow computer performs instantaneous, continuous, and precise gas flow calculations in accordance with American Gas Association Gas Measurement Committee Report #3. This view, with cover removed, shows compact arrangement of solid state modules. A special purpose analog computer usually consists of a custom-designed combination of the following basic modules: operational amplifier, logarithmic modules, function modules, and variable function generators.



HOW DOES A SPECIAL PURPOSE ANALOG COMPUTER DIFFER FROM A DIGITAL PROCESS CONTROL COMPUTER?

As you've probably figured out by now, we've been talking about a custom-tailored single-purpose computer. It does one specific job rapidly and accurately and as many times as you want it to.

Since its single program is built-in, you don't have to train any programmers. Your regular plant personnel can quickly learn to operate it without any off-site training.

This type of computer, of course, doesn't have the broad programming flexibility of a general purpose computer. It is not designed to be changed from one application to another.

But this is an advantage rather than a limitation. For example, great precision and accuracy can be designed into the special purpose analog computer. The cost can be relatively low since the computer contains *only* those components needed for a given application. Control panels can be made more meaningful to operating personnel. For instance, controls and adjustments can be readily identified as to their specific functions.

Special purpose analog computers are designed to operate continuously and reliably in a typical industrial plant environment. Since they will perform satisfactorily over an ambient temperature range of 30°F to 120°F, they need no air conditioning.

A Honeywell special purpose analog computer usually consists of a custom designed combination of the following basic solid-state modules:

1. Operational Amplifier. This is the work horse of the computer system. It can be used to add, subtract, integrate, and perform time delay, gain change, inversion, and memory functions.

2. Logarithmic Modules. These are used for multiplication and division. The module converts a linear function to its logarithm. Two or more logarithms can be added and the antilog taken to provide the product of the inputs. For division, the logarithms are subtracted.

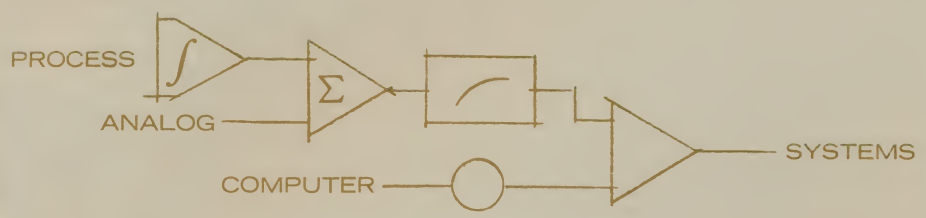
3. Function Modules. These can either square or extract the square root of a quantity.

4. Variable Function Generators. These are used to approximate a nonlinear function that is not a neat mathematical form or that must be calibrated in the field to suit certain process conditions.

After one of these Honeywell computers has been designed to handle your specific requirements, it is then packaged according to your needs. As you have seen, it can be supplied for panel or relay rack mounting or in its own console.

Every computer is thoroughly checked out and tested as a system, and shipped to you ready for installation. If you'd like us to install your computer system we'll be glad to do so. (Our branch offices listed on the back cover are staffed with factory-trained sales and service personnel.) We can also help with startup of your system and training of your operators (what little is needed), and can supply complete maintenance.

So far, we've talked only about the special purpose analog computer itself. And, before leaving the subject we should add that Honeywell computers combine the applicational flexibility and high response speed of electrical operation with the reliability and low maintenance features of solid-state construction. Also, each Honeywell computer comes equipped with calibration and test jacks that let you check out all components quickly and at any time.



WHY SHOULD YOU CHOOSE A HONEYWELL SPECIAL PURPOSE ANALOG COMPUTER?

We're not the only company that builds special purpose analog computers. But we do have the most to offer in helping you realize the greatest economic benefit from this very special kind of computer.

In the first place, we have been co-operating with industrial processors for over 100 years in working out their measurement and control problems. As a result, we can offer a broader line of equipment than any other control systems company. This includes conventional-sized and miniature recorders and controllers (both electric and pneumatic), complete control loops, both analog and digital computers, scientific and test instrumentation such as recording oscillographs and magnetic tape systems, and process control valves. Having no particular axe to grind, we can survey your requirements impartially and tell you whether a conventional control system or an analog or digital computer-directed control system will most economically meet them. And, having recommended a system, we can supply the needed system components including the all-important sensing devices, transmitters, and transducers.

When you think, but you're not quite sure, that you have a problem an analog computer could solve, we're equipped to give you the help you need. Our engineers can analyze your application, help you develop the required equation or mathematical model, and design the computer. Honeywell engineers have at their disposal the industry's most advanced process simulation lab. In it, they can simulate your process on an analog computer (this is a general purpose type rather than the special purpose type we've been talking about).

Suppose your control problem involves the use of proprietary information. Your secret is safe with us. You can just call the different process variables A, B, C and D and they'll work just as well in the equation. We don't even have to know your whole process, just that part dealing with the relationships between A, B, C and D. Of course, we must also know the relative magnitudes of the voltages representing them, and the output desired.

When you deal with us, you get more than just a piece of hardware which you must somehow connect into your process. If you wish, you can get a completely installed system ready to be started up and put to work. We provide scaling, design and layout, calibration and checkout, operating and maintenance instructions, and all needed input and output devices. And, we accept responsibility for the entire system.

HOW CAN YOU RECOGNIZE A POSSIBLE APPLICATION?

Anyone who hasn't been exposed to the simplicity and broad applicational flexibility of the large family of special purpose analog computers can walk past a number of potential applications in his plant several times a day without recognizing them.

One thing to be on the lookout for is a process (or even part of a process) that's particularly hard to control because there's no easily measurable feedback from the product. In many cases of this kind, you can develop a formula that spells out product quality in terms of several process variables. This is a natural for the feed-forward technique of the special purpose analog computer.

Or perhaps you have a large process that looks as though it would lend itself to digital computer-directed control. But you can't predict the results initially or you can't justify the capital expenditure at this particular time. It may be economically feasible to tackle the job in a series of small bites. Apply a special purpose analog computer to a part of the process to learn more about the kind of results you can expect. Or step up the efficiencies of certain parts of the process with special purpose analog computers until you are ready to go to digital computer control.

Maybe you don't have a handy formula or equation worked out, but you still feel that one of these computers could help you improve your operations. Call us in and tell us what you'd like to accomplish. We'll be glad to tell you whether or not a special purpose analog computer is the right answer.

WHOM SHOULD YOU CONTACT FOR HELP?

As you can see from our list of branches on the back cover, there are Honeywell offices all over the United States and Canada. There's bound to be one not too far from you. And, in every branch are people fully qualified to help you decide whether a special purpose analog computer will provide the control you require.

Call the nearest Honeywell office and tell them you'd like to know what a special purpose analog computer could do for you. You'll get expert help with no obligation.

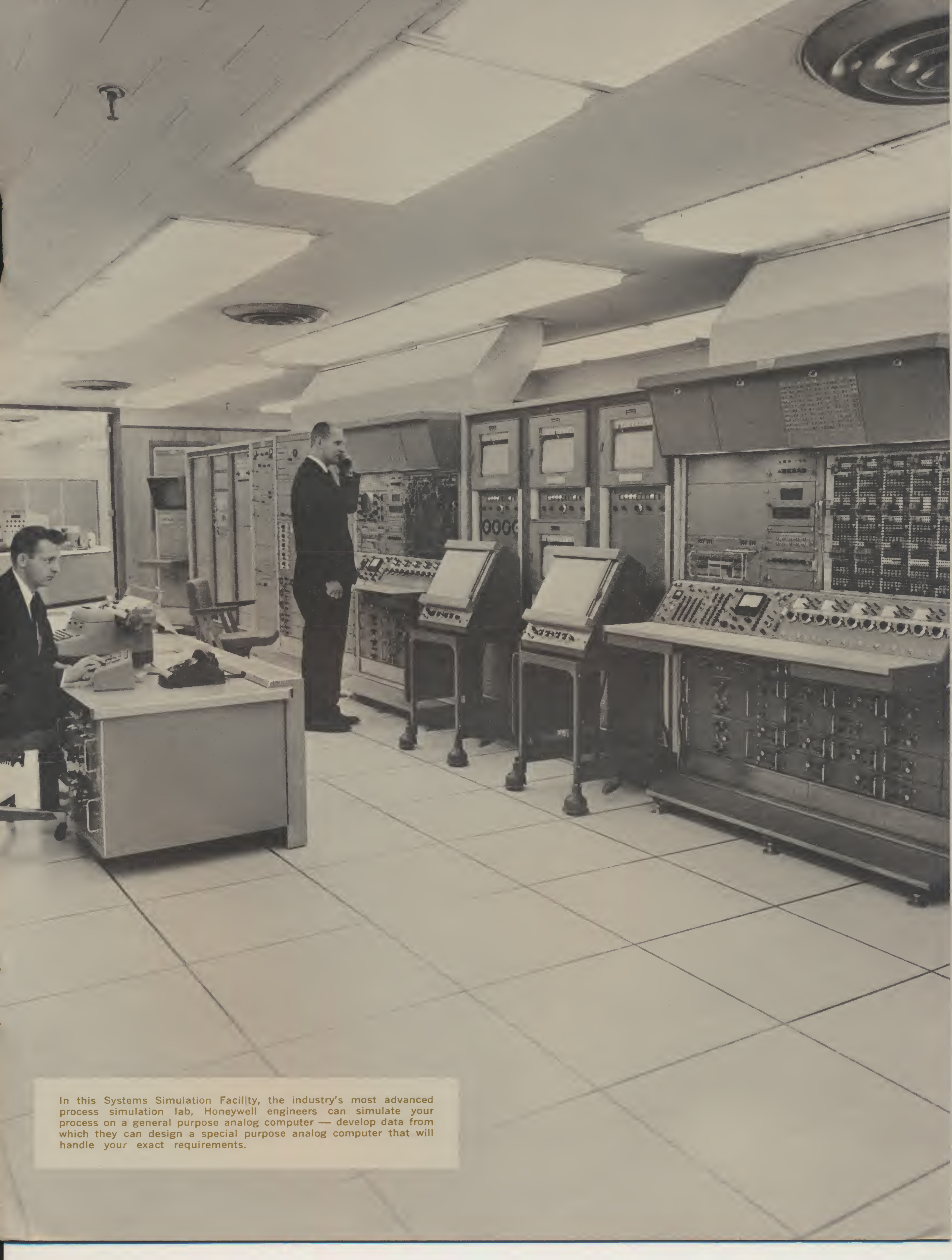
Before we close, we'd like to answer two questions which may have entered your mind since you started reading this booklet. Here they are:

1. *My present control system is pneumatic. Since Honeywell special purpose analog computers are electrical should I forget the whole idea?*

Please don't! We just include in your control system pressure-to-current (P/1) transducers to supply the inputs to your computer and current-to-pressure (I/P) transducers to get the computer's output back into your process control system. We manufacture these transducers, too, of course.

2. *How much would a Honeywell special purpose computer system cost?*

We're not trying to be evasive but we can't give you a nice tight dollars-and-cents answer to this one. Remember, each special purpose analog computer is custom-tailored around a specific application. The cost of your computer system will depend on just what you want the system to do. However, based on jobs that we have done (ranging from the simplest to the most sophisticated applications), we can say that the cost is likely to be somewhere between $2,000 and $50,000.



In this Systems Simulation Facility, the industry's most advanced process simulation lab, Honeywell engineers can simulate your process on a general purpose analog computer — develop data from which they can design a special purpose analog computer that will handle your exact requirements.

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